



Forest Insect & Disease Management

Report No. 79-1-20
May 1979

PREVENTATIVE MEASURES TO PROTECT HISTORIC STRUCTURES: A CASE HISTORY OF THE HENSLEY SETTLEMENT



SOUTHEASTERN AREA, STATE & PRIVATE FORESTRY
USDA FOREST SERVICE, ATLANTA, GA 30309

PREVENTATIVE MEASURES TO PROTECT HISTORIC STRUCTURES:
A CASE HISTORY OF THE HENSLEY SETTLEMENT

U. S. DEPARTMENT OF AGRICULTURE FOREST SERVICE
SOUTHEASTERN AREA, STATE AND PRIVATE FORESTRY

AUGUST 1978

PREVENTATIVE MEASURES TO PROTECT HISTORIC STRUCTURES:

- A CASE HISTORY OF THE HENSLEY SETTLEMENT

by

William H. Sites, Patrick J. Barry^{1/} and Francis G. Wagner, Jr.^{2/}

- 1/ Plant Pathologist and Entomologist respectively, USDA, Forest Service, Southeastern Area, P. O. Box 5895, Asheville, N. C. 28803
- 2/ Wood Protection Specialist, USDA, Forest Service, Southeastern Area, 910 Milner Building, 210 South Lamar Street, Jackson, Miss. 39201

ACKNOWLEDGEMENTS

We thank the Superintendent and staff of the Cumberland Gap National Historical Park, Kentucky, for their assistance on the preparation of this publication. Their facilities provide the examples cited, and offer guidance to many who wish to restore or maintain buildings under similar circumstances.

The use of a trade name in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U. S. Department of Agriculture or any product to the exclusion of others which may be suitable.

CONTENTS	Page:
Introduction	1
Principles of Wood Decay	2
Principles of Insect Damage to Wood	5
Anobiid Beetles	6
Lyctid Powder Post Beetle	6
Old House Borer	7
Carpenter Ants	8
Carpenter Bees	9
Termites	9
Chemical Control.....	10
Principles of Wood Preservatives	11
Types of Preservatives	12
Quality Marks, Tags or Brands	15
Precautions.....	17
Wood Durability Related to Cost of Treatment	18
Brush, Spray or Dip Treatments.....	18
Soaking or Steeping Treatments.....	19
Hensley Settlement: An Evaluation of Historic Buildings ..	23
Recommendations.....	46
Summary	47
Suggested Reading	49

INTRODUCTION

As our Nation moves into its third century, more public and private organizations and individuals are working to preserve notable buildings of the past. Many wooden structures of historic interest will continue to enrich our heritage if the proper measures are taken. This guide is intended to help organizations and individuals in this work. The task is not as easy as it may appear. Old buildings frequently require different techniques than those used in the maintenance of homes built in recent times. Buildings constructed in previous generations differ in quality of materials as well as in design and construction techniques. What principles do you need to consider if you are involved in the restoration or preservation of such buildings? How do you go about the task? This publication will help you establish a perspective on these questions. Guidelines are offered on the basis of experience at the Hensley Settlement, Cumberland Gap National Historic Park, Kentucky. Many of the recommendations are appropriate for other historic structures. These guides will help to decide what not to do, as well as how to go about the job.

Structures that are true "antiques" are being restored as well as recent structures. Some are restored as private residences, while a far larger number are being restored for historical reasons. Many Federal, State and private organizations are

undertaking the task of preserving our heritage by rehabilitating and protecting historic structures and their contents.

This publication is about a group of rehabilitated structures at the Hensley Settlement, Cumberland Gap National Historical Park, Kentucky. In it we have attempted to: (1) discuss wood decay and wood destroying insects in general, and (2) provide an evaluation and specific recommendations for individual structures at Hensley. You will find many of these recommendations are appropriate for other historical structures.

PRINCIPLES OF WOOD DECAY

An abundance of information is available on the protection of wood buildings and other structures. Builders of a century or more ago did not have this information and yet many of their structures survived. Why?

Yesterday's builder possessed a lot of common sense and some tangible advantages. Much of the material he used was of resistant quality. Chestnut, walnut, heart pine and old-growth cypress were commonly used. However, these species are no longer available or are uneconomical for structural construction.

Many old buildings were well ventilated and had few internal sources of moisture. The crawl spaces were often exposed and wall and roof construction was not tight. The conditions provided for good circulation of air. Thus, the buildings remained dry, or dried quickly when they did get wet. Indoor plumbing, central heating, central air conditioning and insulation were non-existent. Thus, water from leaking pipes, vapor from bath showers and temperature gradients resulting in condensation were unknown. Poor heating also reduced the activity of decay fungi and wood destroying insects in cooler climates.

Yesterday's builder also kept his construction simple. Roofs were usually straight with a steep pitch. As a result, there were few or no valleys that might leak. Rain and melted snow ran off rapidly. Basements were uncommon because they were difficult and time consuming to dig. Thus, sources of water within and under the foundation were minimized.

So far, this discussion has made clear the first principle of wood protection -- Keep It Dry. Through loose construction, simple designs, and a lack of modern conveniences our forefathers did just that. And, as long as these and other similar structures are maintained in the same manner, the risk of decay and insect attack is reduced.

Decay results when fungi digest the wood.. Water, oxygen and a favorable temperature are essential to the process. Obviously, oxygen and temperature cannot be controlled in most buildings. 1/ The single factor you may control is moisture. Because you probably are dealing with loose construction, no central heat or air conditioning and no indoor plumbing, your major concern, will involve water from outside.. It can come from below, if wood is in contact with the ground, from above, if the roof leaks or the chimneys are not properly flashed, or from the sides, as in the case of wind driven rain. Condensation from fog may also wet the building.

Wood is like a sponge. Its cellulose walls absorb water. This occurs when the humidity (moisture content) of the air around the wood increases or when wood dries out when the humidity is low and when it is not in contact with free water. It will, however, take up water much quicker and easier than it will release it. The amount of water necessary for decay is that at wood fiber saturation. This condition exists when the cell walls have absorbed as much water as they will hold. For most species it occurs between 25 and 20 percent wood moisture content.

1/ Wood submerged in water will decay very, very slowly, because oxygen is not readily available. Hence, wood water wheels may last for many years if kept turning in or under water.

A moisture content above 22 percent should be viewed with concern.

Indications of a high moisture content are numerous. Visual indicators are; free water on the surface, water stains, and mold (non-decay fungi) on the surface. Moisture content of wood can be measured with a moisture meter. One such device is manufactured by the Delmhorst Instrument Company, Boonton, New Jersey 07005. The battery powered, pocket Model J-1 costs about \$160. Few meters are 100 percent accurate. However, they can provide comparative readings for a general evaluation.

PRINCIPLES OF INSECT DAMAGE TO WOOD

Four major groups of insects bore into wood and weaken it. They are beetles, carpenter ants, carpenter bees and termites.

Three different beetles can cause enough damage to wood to warrant control. As in the case of decay fungi, two types are attracted to moist wood. Therefore, the best method to control is to keep wood dry. The only exception is the old house borer.

Anobiid Beetles

Anobiid beetles need moist wood. They generally attack unpainted wood under houses, cabins, and outbuildings where poor ventilation permits damp conditions. They attack both hardwood and pine species. Damage is generally hidden from view, but on closer examination can be found in floor joists, sub flooring and sill logs. This beetle may also get into a previously uninfested structure through infested or unseasoned wood used in repairs. For this reason, firewood or lumber should not be stored on the ground under or near structures. In addition, replacement materials, such as those from other old buildings should be closely inspected for damage.

These beetles make exit holes about one-eighth inch (0.32 cm) in diameter (figure 9). Fresh boring dust will indicate the presence of beetles. All the beetles may have died or migrated before you discovered signs of their attacks, so the presence of holes may not signify an active infestation.

Lyctid Powder Post Beetle

A second important beetle is the lyctid powder post beetle. This pest attacks only hardwood. It is commonly found in window

and door frames, wooden mantels, shelves, hardwood floors, cabin logs and furniture. Like the anobiid beetle, it can be introduced through the use of poorly seasoned or infested materials.

Adult lyctiid beetles leave the wood via holes about one-sixteenth inch (0.16 cm) in diameter. Infested wood has the appearance of being peppered with birdshot. Because holes may indicate an inactive infestation, the area around them should be examined for new sawdust about the consistency of flour. Damp wood in moist, poorly ventilated locations is subjected to attack. This could occur in crawl spaces, attics and closed sheds and other buildings.

Old House Borer

The third beetle is the old house borer. It can feed on wood that is drier than that required for the two previous beetles. However, it also readily attacks damp wood in poorly ventilated crawl spaces, attics and closed sheds and other buildings.

This beetle can successfully attack freshly kiln dried lumber. Although called the old house borer, it can infest

new structures or new replacement parts of old buildings. In fact, it is frequently introduced into structures in this manner.-

The exit hole of the old house borer is oval shaped. It is about one-fourth by one-eighth to three-sixteenths of an inch (0.64 by 0.32 to 0.48 cm) in size. The beetle attacks only sapwood of softwood species such as southern pine, Douglas-fir and spruce. Old growth heartwood in old structures is usually not attacked; however, new replacement parts of old buildings can be invaded.

Carpenter Ants

Carpenter ants do not feed on wood. They use it for shelter and nesting purposes only, and prefer wood that is naturally soft or decayed. This insect most often attacks porch supports, porch roofs, window and door sills, sill logs, and sometimes wood plates in foundations. The logs in cabins may also be attacked.

The ants' nests should be destroyed. If left undisturbed, the ants can, in a few years, enlarge their tunnels to the point where replacement or extensive repairs are necessary.

Measures described earlier to prevent decay are also very effective against the carpenter ant. Here, again, moisture is the key. Prevent it and the carpenter ant will not be a problem. This insect is a very good indicator that decay is present in a building or there is some decaying wood present close to the structure. Firewood or other wood stored under a building can harbor ants. Good sanitation is important in controlling them.

Carpenter Bees

Carpenter bees, like carpenter ants, do not feed on wood, but use it only for shelter and nests. They generally attack well-weathered, moist or dry wood. They look very much like bumblebees except they don't have yellow on the abdomen and they have shiny, black posteriors. Their galleries are usually four to six inches long (10 to 15 cm) and about one-half inch (1.3 cm) in diameter. They tunnel into the end grain of wood members such as door and window sills, porch ceilings, window and door frames, headers, siding and logs in log cabins. In some cases they can weaken some supportive members such as porch pillars and floor joists.

Termites

Termites are the most serious of the wood destroying insects

in the United States. There are two types, the subterranean termite and the dry wood termite. Dry wood termites are confined to the southeastern and southern coastal regions of the United States, and west along the Mexican border to California. The subterranean termite ranges throughout the United States except the upper Midwest and extreme Northeast. These termites maintain a direct link to the ground. To make this connection, they build earthen tubes over or through cracks in masonry and wood piers and onto wood above. Therefore, any break in soil contact will destroy the colony.

Termites eat wood and weaken it structurally. They also bring moisture and soil with them to the wood, which leads to attack by wood decay fungi. Here, again, we see the importance of controlling moisture in wood. In addition to their earthen tubes, termites can be identified by their appearance. Termites have a thick waist and four wings that are all equal in length. Ants, in contrast, have a thin waist. In addition, ant front and rear wings are different lengths.

Chemical Control

Chemicals can control the insects described previously. If you have an insect problem, contact a qualified person for specific recommendations. Your county agent or a commercial

pest control firm can give you further information.

PRINCIPLES OF WOOD PRESERVATIVES

As mentioned earlier, the best way to protect wood from decay and insect attack is to keep it dry. However, some wood used in building construction will not remain dry. These items should be made from pressure treated wood. Pressure treated wood should be used whenever wood is in contact with the soil, directly on a concrete slab, in water, or in a location where it will frequently get wet. Perhaps the greatest hazard to wood in building construction is where the wood is used in contact with the soil. Wood at the soil surface or just below the ground line remains at optimum moisture for attack by decay and termites. Wood used above ground, but exposed to rainfall, is much more variable in its vulnerability to damage by the volume and type of rainfall, amount of drying weather, type of structure, amount of exposed end-grain, and many other factors.

The selection of the type of pressure treated wood should depend on the end use of the wood. Purchase pressure treated wood suitable for its intended use. This use determines the type of preservative and also the amount of preservative needed to protect the wood. For example, more preservative is needed

to protect wood used in contact with the ground than wood above ground. The American Wood Preservers' Association (AWPA) has issued standards which specify the types of preservatives, quantities, and penetrations needed to protect wood for different uses.

Types of preservatives. -- Three major types of preservatives are used for pressure treatments of wood:

Creosote. -- An oily, dark preservative effective against most wood destroying agents. Freshly creosoted wood has a strong petroleum-type odor. Creosote treated wood cannot be painted because of the tar like coating on the exterior of the wood. Creosote treated wood is suitable for fence posts and railings when appearance is not a major factor. Some people develop a rash when bare skin is exposed to creosote treated wood. Also, some vegetation may be burned by creosote. Therefore, use creosote treated wood only where physical contact with humans, animals and plants is unlikely.

Pentachlorophenol (penta). -- An oil soluble powder preservative effective against decay and termites. When the penta powder is mixed with a carrier of heavy oil, the properties of the treated wood are similar to wood treated with creosote.

When penta is mixed with a light oil carrier, the treated wood has little odor, is similar in color to untreated wood, and can usually be painted or stained. Where a completely clean surface is needed, wood can be treated with a mixture of penta in liquified petroleum gas (LPG). During the treating process, the LPG is flashed off, leaving only solid penta in the wood. The treated wood is clean and dry and will accept any type of finish. Penta treated wood should not be used in enclosed spaces. Also, penta treated wood should not come into contact with vegetation or animal life.

Waterborne preservatives. -- Chemicals dissolved in water for pressure treatment of wood. The most commonly used waterborne preservative is chromated copper arsenate (CCA). CCA is a permanent preservative and is effective against decay and termites. During the treating process, CCA reacts with the wood so that the preservative becomes fixed in the wood and cannot leach out with subsequent wetting. Treated wood is clean and odorless and may be painted or stained. The treated wood has a slightly greenish color that fades as the wood weathers. CCA treated wood is the most acceptable treated wood to be used around buildings. This wood may be used for plant boxes, greenhouses, decks, stairs, and even foundations. Wood treated with waterborne preservatives should be kiln or air dried before using it in

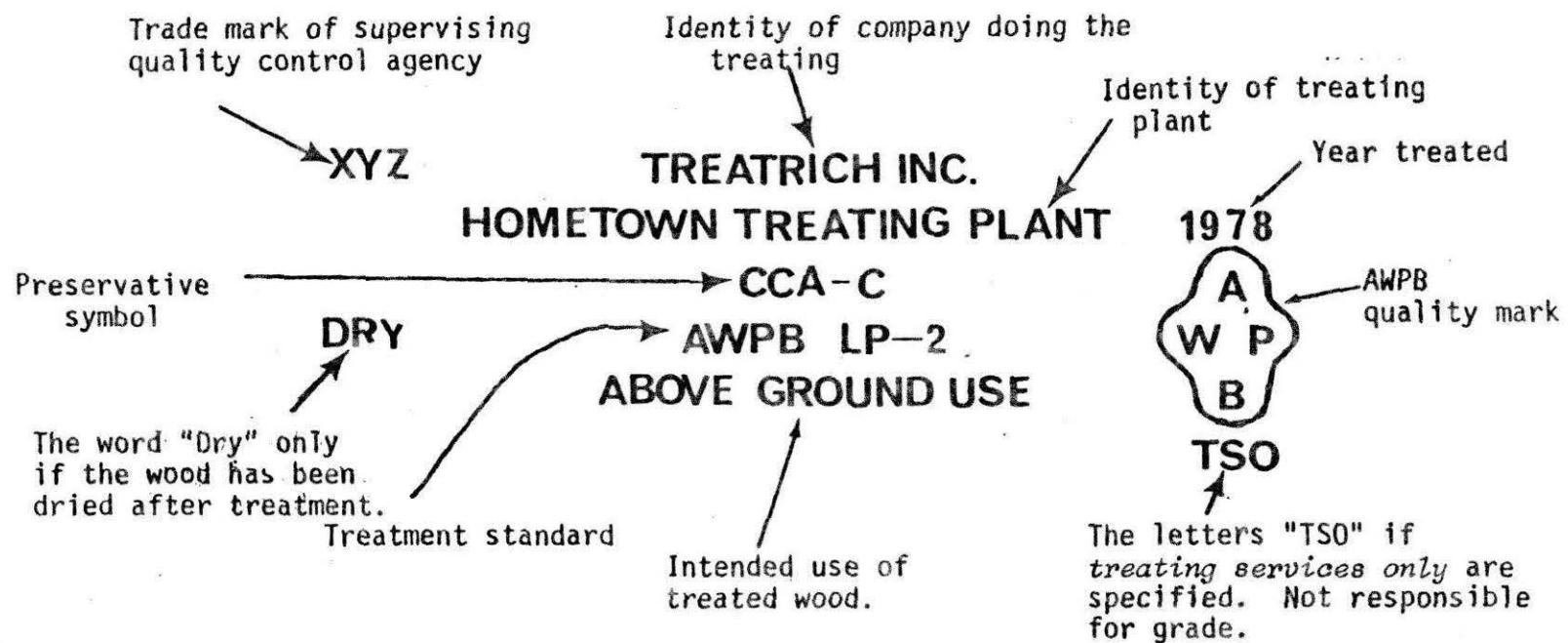
buildings to minimize the shrinkage that would occur if the wood were allowed to dry after construction.

At one time, it was believed that the only preservatives suitable for wood that comes in contact with the ground were the oil-borne preservatives (creosote and penta). With the advent of leach resistant, waterborne preservatives, this belief becomes invalid. Service records show that wood stakes treated in the 1930's and 1940's with both types of preservatives and put into contact with damp soil are still sound. Wood that has been properly treated for its intended use should last for at least 30 years.

Quality Marks, Tags or Brands

Select treated wood that has a quality mark, tag or brand. The quality mark indicates that the wood meets strict quality control standards. The American Wood Preservers Bureau (AWPB) inspects the wood and, if standards are met, marks it accordingly (figure 1). Creosote and penta treated wood usually do not carry a quality mark, but may be branded or tagged. In any case, ask for proof that the wood was treated to meet standards. The quality stamp or proof of treatment should contain the name of the treating company, the preservative used, the standard to which the wood was treated, and the intended use of the treated wood. Again, use treated wood for its intended use. If the quality mark is for above ground use, the wood will not serve well in ground contact. If the wood is marked for ground contact use, it will also serve well above ground but the cost is higher than that treated for above ground use. Any wood used in the foundation of a building must carry the AWPB-FDN (FDN=foundation) quality stamp. The preservative retention of FDN treated wood is higher than that of wood treated for other kinds of ground contact. It will lend added protection to the difficult-to-replace wood in a foundation.

Figure 1.--AWPB Quality Stamp.



Precautions

All wood preservatives used today are toxic to living organisms, both plant and animal. However, treated wood imparts a small risk to humans, livestock, wildlife, growing crops, plants, and flowers when properly used. Conditions under which the wood is used must always be considered. Oil-type preservatives are low in water solubility. This quality minimizes risks of pollution of water supplies. Creosote and penta treated wood does have an irritating effect on skin. As the treated wood weathers, however, the irritating effect is reduced. Some minor constituents of creosote are also suspected of being carcinogenic. Anyone who handles creosote or penta treated wood should wear solvent resistant gloves. Both creosote and penta treated wood emit small amounts of vapor. To reduce the build-up of these vapors, the wood should only be used out of doors. CCA treated wood emits no toxic vapors and is not soluble in water. CCA treated wood may be used with relative safety for most uses in and around structures. Contact with CCA treated wood before the wood is dry could cause poisoning by the chromium, copper, or arsenic constituents. However, once the wood is dry, these elements are permanently locked into the wood.

Wood Durability Related to Cost of Treatment

Pressure treated wood costs about 50 percent more than untreated wood. However, most often the cost of preservative treatment is a very small percentage of the total in-place cost of a treated wood product (considering labor and handling costs). The cost of preservative treatment can be easily justified when one considers that untreated pine in contact with the ground will last only about 1 or 2 years and treated pine will last 30 years or more.

Brush Spray or Dip Treatments

Preservatives are often applied by brush, spray or dip. This treatment is of little or no value for wood in contact with the soil. Also, it is of questionable value for other applications because of very shallow penetration of the preservative into the wood. Repeated applications of preservatives by these means may increase the penetration somewhat but normally not over 1/32 of an inch (0.08 cm). Checks in the surface usually expose untreated wood, making it susceptible to decay.

Dipping of wood in preservative materials is useful where there are many exposed end-grain surfaces. It is used extensively

in applications such as window and door manufacture. For general use, however, dip treatments are little better than brush or spray treatments and should not be used for ground contact-applications.

Soaking or Steeping

The preservative penetrates to a greater depth than in any of the methods described previously when it soaks and steeps (prolonged soaking) into dry wood. Cold soaking, for periods from 24 hours to 2 weeks, will give maximum penetration and retention. Longer soaking normally will not increase the penetration. This method gives good results with seasoned material. A substantial increase in service life over that of untreated wood can result when wood is properly treated by the cold soak method. One disadvantage of the process is that there is little control over the amount of preservative retained in the wood. In some cases, the amount of preservative in the wood is even excessive, resulting in high treating costs.

Select and treat fence posts by the cold soaking method as follows:

1. Use wood that is easily treated such as Southern pine, red oak, black gum or green ash. Always use the smallest size timber that will satisfy your needs.

2. Choose posts with large amounts of sapwood. Sapwood can be treated more easily than heartwood. Also, select posts that are free of decay to insure durability after treatment.
3. Peel the bark from the posts as soon as possible after they are cut. This will allow the posts to dry and accept treatment more easily. Remove the bark with a mechanical peeler, draw knife, hoe (spud), or shovel.
4. Stack the posts for drying so that air can circulate freely around them. A crisscross pattern (crib) with layers in opposite directions, works well for drying posts. Support the first layer at least 1 foot (30.5 cm) off the ground on concrete blocks or other non-wood items. Dry the posts at least 90 days in the summer and longer in winter.
5. Sort the posts for treatment according to diameter and species of wood. Posts of different species and diameter require different treatment schedules. The diameter and length of each post determines the amount of preservative needed to treat the post to a given preservative retention. Table 1 lists the

volume of preservative needed to treat posts
of various sizes to an average retention of
- 8 pounds per cubic foot (128 kg/m^3).

6. Choose a treating tank that is large enough to hold the number of posts that you would like to treat and the preservative. Place the posts in the tank and weight them to keep them from floating.
7. Barely cover the posts with preservative. Then add whatever additional amount of preservative that will be needed to treat the posts as determined from Table 1.
8. Soak the posts in the tank until the preservative level returns to the top surface of the posts. This may take from 24 hours to a week.
9. Remove the posts from the tank and drain them so that the excess preservative on the surface of the posts will drip into the tank.

Table 1. -- Amount of solution required to treat round fence posts to an average retention of 8 pounds of creosote and penta per cubic foot of post.

Diameter of posts midway between ends <u>inches</u>	Preservatives needed for posts of 3 lengths (feet)		
	<u>6</u>	<u>7</u>	<u>8</u>
..... pints			
3	2.5	3.0	3.5
4	4.0	5.0	6.0
5	6.5	7.5	9.0
6	9.5	11.0	12.5

THE HENSLEY SETTLEMENT
AN EXAMPLE OF GUIDELINES USEFUL
IN MANY PRESERVATION PROGRAMS FOR WOODEN STRUCTURES

The Forest Service's Southeastern Area cooperated with the National Park Service in a study to determine the most effective methods to preserve a group of historic wooden buildings constructed in the early 1900's in what is now the Cumberland Gap Historic Park, in Kentucky. The condition of these buildings is similar to that of many structures being restored by other public or private organizations and individuals. Accordingly, many of the suggestions for preservative treatment of the buildings in the Hensley Settlement could be profitably employed elsewhere. The following sections describe the condition found in the Hensley Settlement, and suggest ways to protect the buildings from attack by insects and decay organisms.

Park Hensley House

This building rests too close to the ground. The outer porch sill log is partly buried in the soil (figure 2). The sill has a moisture content exceeding 30 percent and is beginning to decay. Decay will also destroy the floor boards that rest on this sill.

It is not practical to raise the porch sills and the floor;

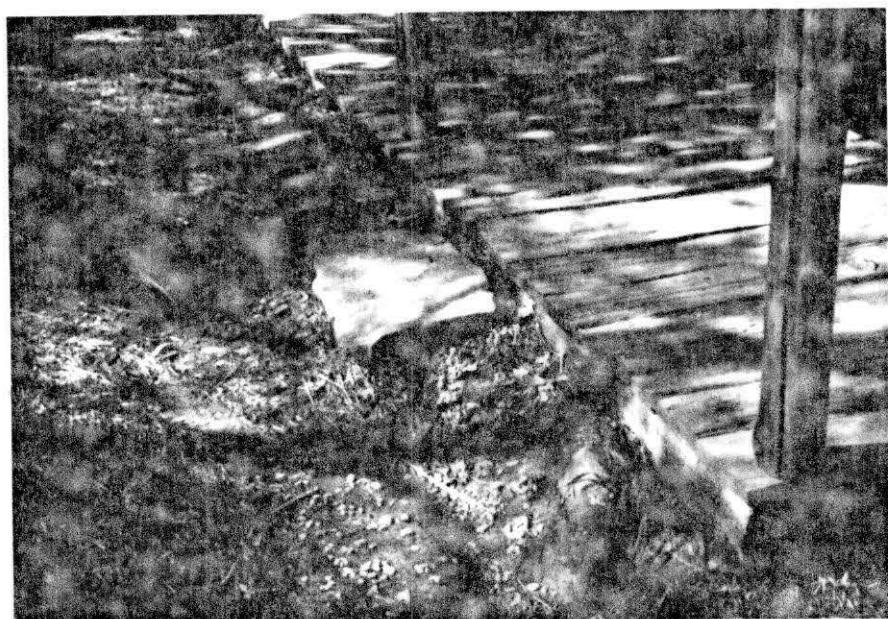


Figure 2.--Outer porch sill is in contact with the soil.
Contact with soil should be broken.

therefore, drainage around the house should be improved to divert water away from the building. A wide, gently sloping ditch should be dug at the front of the porch. The grade should slope away from the porch. The ditch will divert water that previously ran under the porch from the hill above the house. The runoff from the porch roof will also be diverted from the building.

In addition, the soil from the front and underside of the sill should be replaced with stone piers. These changes will remove a source of moisture and improve the ventilation under the porch.

Because the house ceiling is insulated, ventilation should be improved in the attic to prevent condensation of water vapor. There should be a minimum of 1 square foot of vent to every 150 square feet (or 10 cm^2 per 15 m^2) of attic area. This can be done by installing louvered vents in the gables. This ratio of 1 to 150 should be maintained in all attics and basements, especially if the buildings are to be cooled, heated or insulated.

The end grain of the top front and rear wall logs is exposed (figure 3). The end grain absorbs moisture faster than the grain in any other dimension. In this case, the ends are directly exposed to rain and may begin to decay. If they are not actually functioning as support for the floating rafters, they should be trimmed back to the wall.

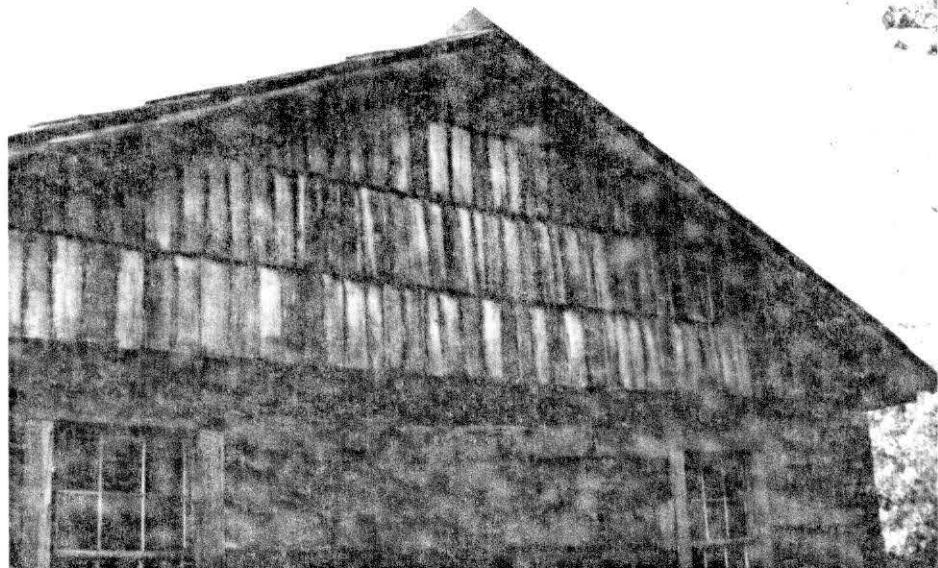


Figure 3.--Exposed end-grain of top wall logs will absorb moisture. The ends of these logs should be sloped back toward wall, or trimmed flush with other log ends, if not functional.

Several problems are directly associated with the basement. There is inadequate ventilation. The block walls are wet. The north wall is shimmed with wood which could be an eventual source of termites. The floor, floor framing and sill under the east corner of the fireplace are wet (figure 4). Water runs off the house roof and down into the basement stairway.

To improve ventilation, the windows should be opened and screened. In addition, a concrete block could be removed and a screened vent installed near the top corners of the east wall under the porch. With improved ventilation under the porch floor, air could move into the basement. This measure, along with improved drainage around the porch and chimney, should help dry the basement.

All wood shims at the bases of the walls should be removed. If termites have become established, treatment by a qualified exterminator may be necessary.

The chimney should be flashed at its junction with the roof. Runoff from the roof flows down the chimney and finds its way into the floor and framing below. The chimney should also be covered with a loose or tight cap depending on whether it is to be used. Water should not be permitted to run down into the firebox.

A roof should be built over the basement stairs to keep water from running into the basement from the house roof. An

extension of approximately 10 by 10 feet (3 by 3 m) should be sufficient.

Two items that should have been installed when the house was rebuilt were pressure treated sill plates and termite shields. The existing untreated sills are subject to insect attack and decay in their moist environment (figure 4). Termite shields, even though they can be bridged by the insects, can force them to a surface where their mud tubes can be observed.

School House

Overall, the school house is in fairly good condition. Some sill logs are closer than 12 inches (30.5 cm) to the soil. However, the building has adequate clearance for most of its perimeter and good ventilation in its crawl space (figure 5). Drainage is also good.

The juncture of the porch roof and house wall should be flashed. Raise this siding 2 inches (5 cm) above the shingles and insert metal flashing that will extend under the shingles and siding. This may be difficult but should be considered if there is reason to do any work on the roof in the future. The roof of this building was not inspected. However, stains on the ceiling indicate a present or past leak in the roof or upper walls (figure 6). All leaks should be stopped.

The clay based mortar between the logs could become a source of trouble (figure 7). Wood should be kept dry. Walls

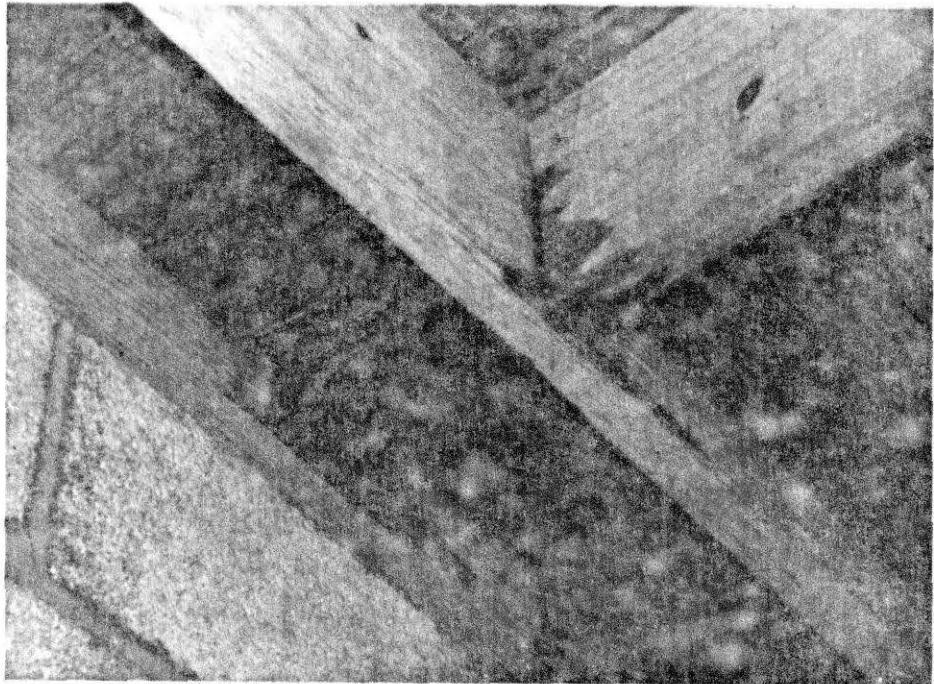


Figure 4.--Flooring and framing are wet. The source of moisture is a roof-chimney joint that should be flashed. The sill should have been of pressure treated lumber.

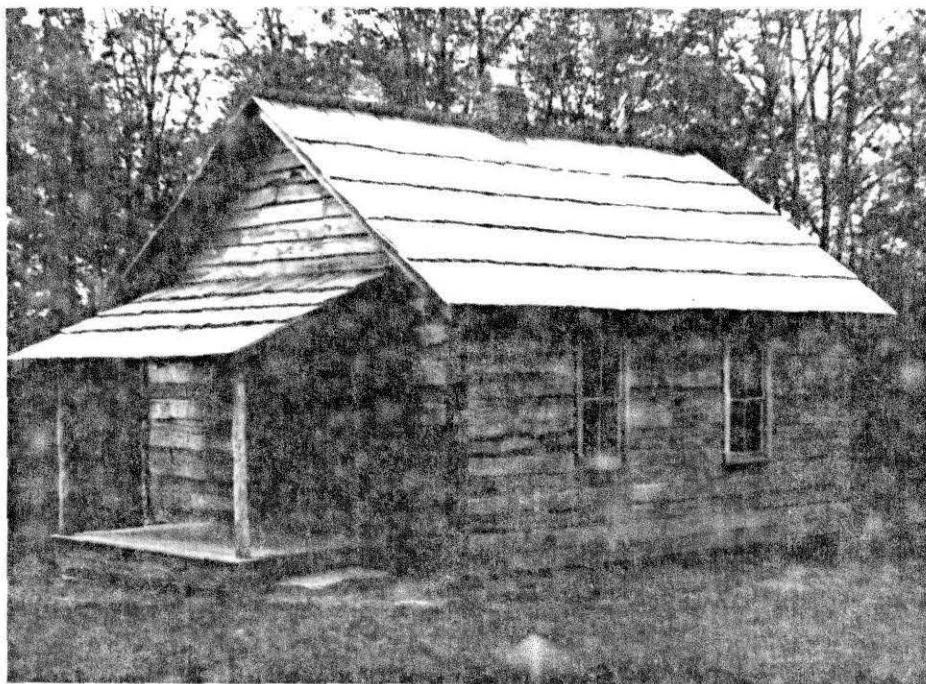


Figure 5.--The crawl space of the schoolhouse is well ventilated both by height above ground and lack of solid underpinning. Note also, absence of flashing at juncture of porch roof and front wall.

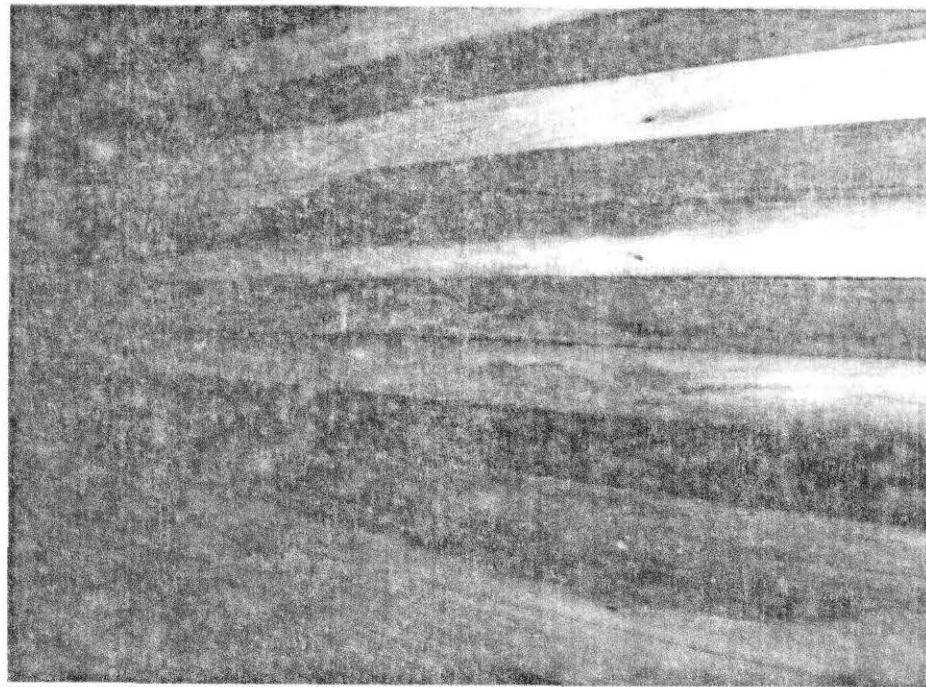


Figure 6.--Water stains on the ceiling of schoolhouse.
The source should be located and the leak
repaired.

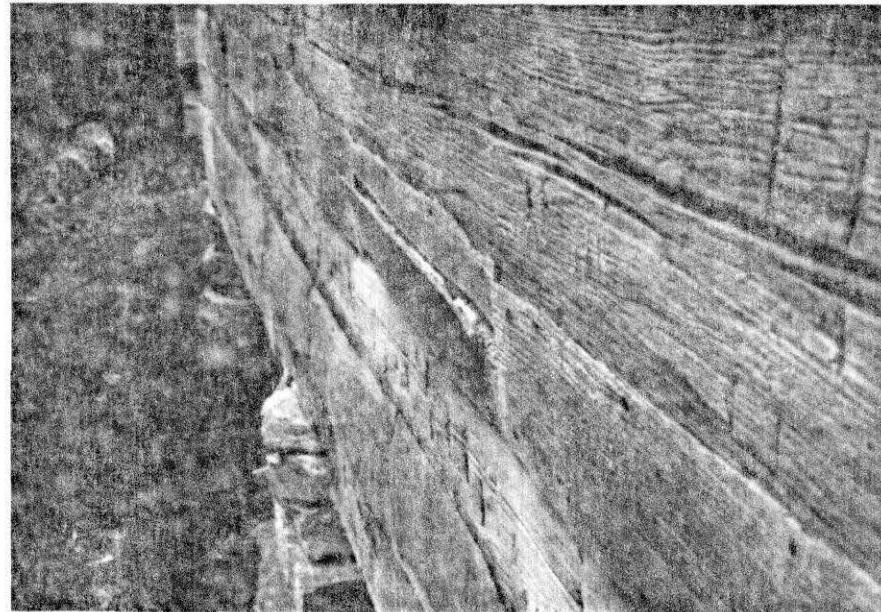


Figure 7.--Mortar such as this can trap and retain
water. Perhaps it should have been omitted.

constructed like this one can trap water in the mortar behind the log battens. Once trapped, the wood will dry slowly and decay can proceed. Perhaps, in the future, buildings should be reconstructed without this water-trapping and holding material.

At the school, wood has been stored under the building (figure 8). In this and other cases, such debris should be removed. Termites, carpenter ants and wood-destroying beetles can infest this material and move into the building above.

The seat in the outhouse, southwest of the school house, contains active beetles (figure 9). No chemical control is recommended, since the seat can be easily replaced when necessary. This building is also too close to the ground and is poorly drained (figure 10).

Lige Gibbons Farm

House. -- The northern end of the house is too close to the ground (figure 11). The soil should be removed from the sides and underneath sills where there is contact. The sills should then be placed on stone piers. A full 12-inch (30.5 cm) separation of wood and soil will involve a larger excavation project. A wide gently sloping drainage ditch should be dug.

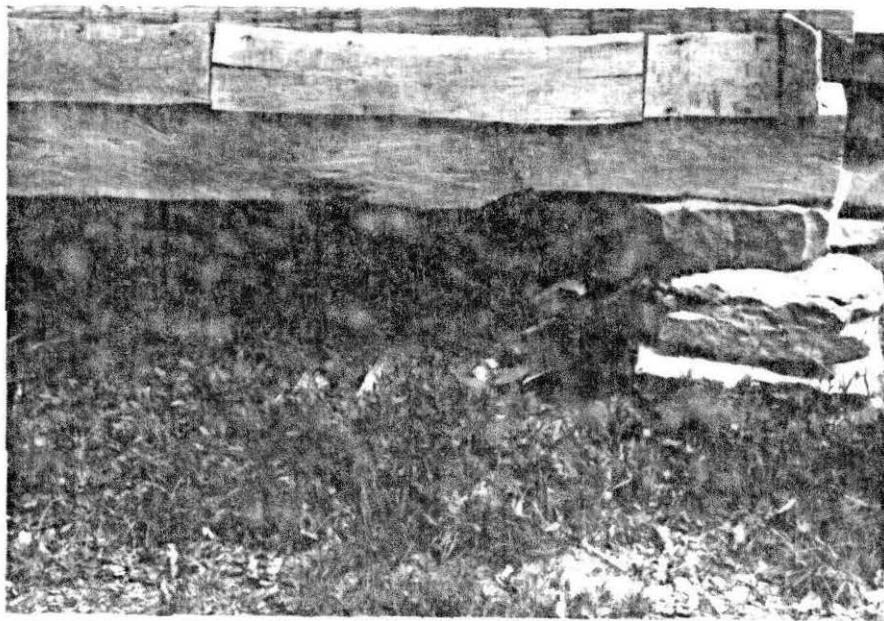


Figure 8.--Wood debris stored under the schoolhouse.
Material like this attracts wood-destroying
insects to the building.

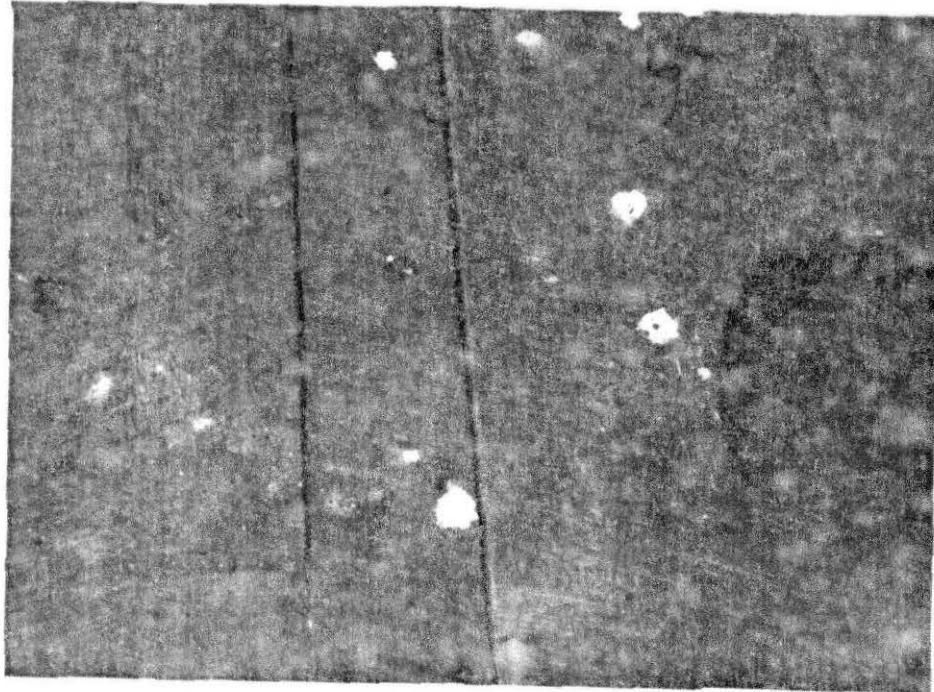


Figure 9.--Piles of fresh sawdust demonstrate the
presence of active infestations by beetles.
In this case, replacement of the seat would
be more appropriate than chemical treatment.

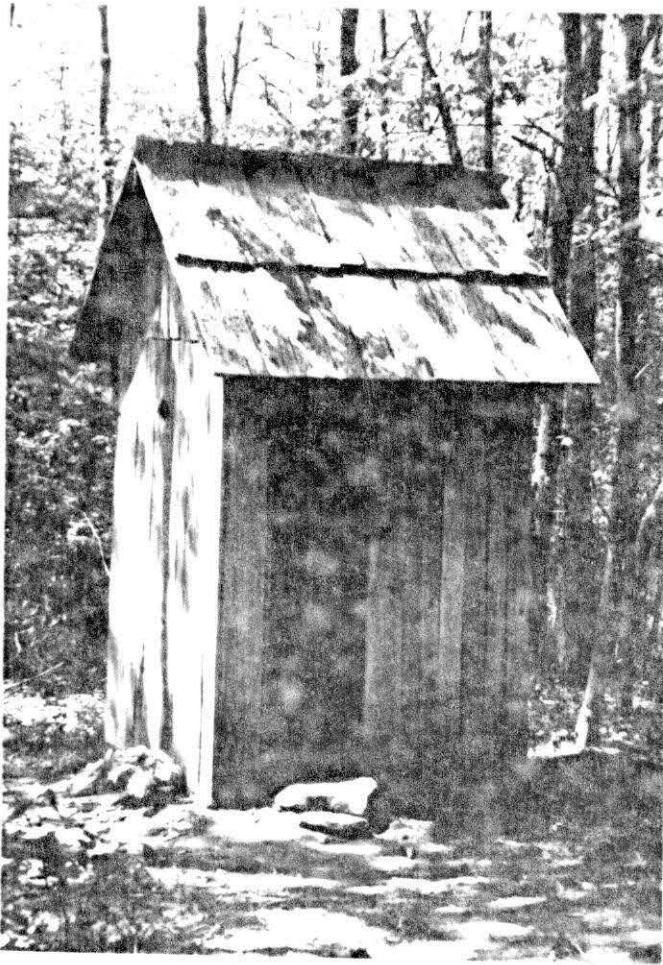


Figure 10.--The school outhouse is too close to the ground.

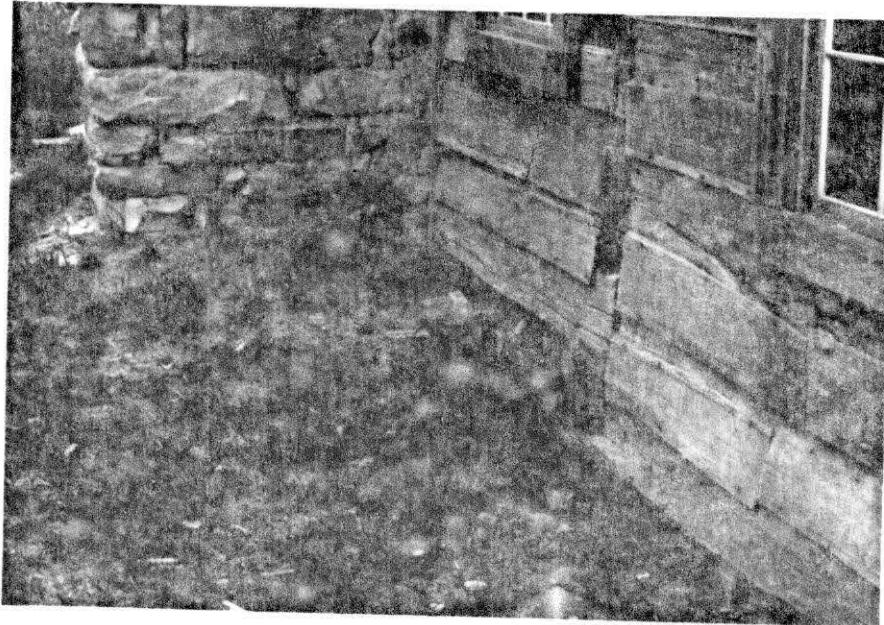


Figure 11. Wood sills are within 12 inches (30.5 cm) of the soil. Soil should be removed and wood members placed on stone piers.

at this end of the house. The grade should slope away from the house. A ditch built in this way will also have to be kept free of debris, soil fill, and vegetation other than grass.

The attic ventilation needs to be improved in the same way indicated for the Park Hensley house. The roof should also be inspected for leaks.

The chimneys should be flashed and capped. The wood support post for the kitchen chimney (figure 12) should be raised off the ground. This could be done now, or when the post has to be replaced.

Wood debris under the house should be removed. Again, it attracts insects that can move into the house.

The stepping stone at the kitchen door was moved as recommended (figure 13). Previously, rain running off of the kitchen roof splashed from the stone to the sill log. The log became wet and had begun to decay. By removing a source of water, the log should stay drier and last longer.

Outbuildings. -- Most of the outbuildings, such as the

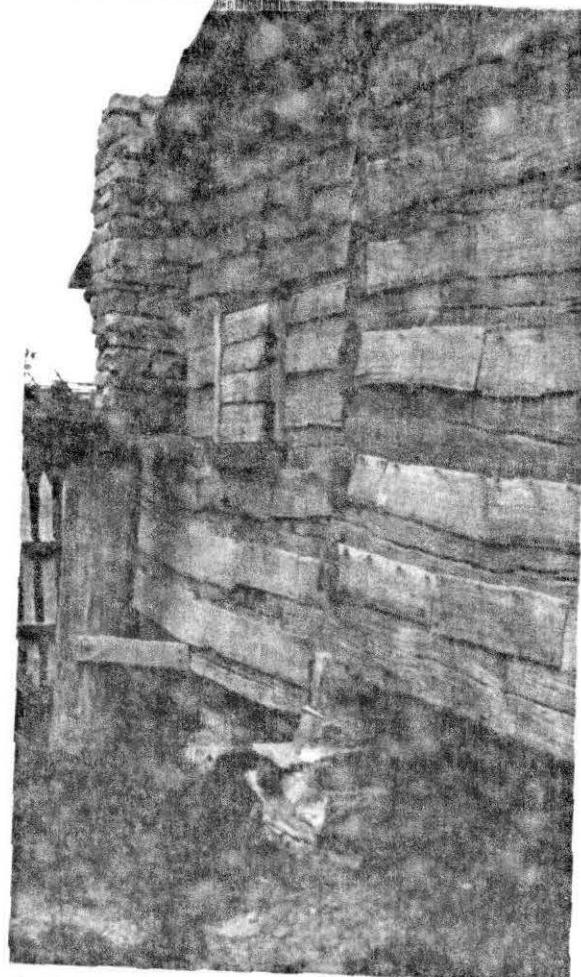


Figure 12.--The bottom end of the wood support post for the kitchen chimney will probably decay, with time. It should be set higher off the ground on stone.

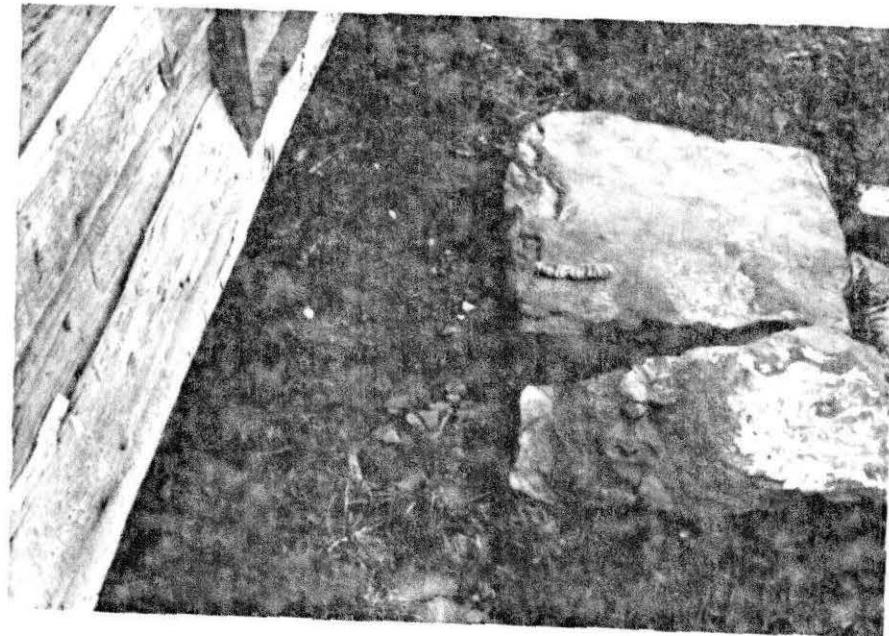


Figure 13.--Stepping stone at the kitchen door. It is now away from the drip line. As a result, the sill above will remain drier. Notice decay fungi fruiting bodies that were removed from the sill.

corncrib and barn, are too close to the ground (figure 14). The center sill of the barn (figure 15) has begun to decay. Only a reduction in moisture content will slow the decay. Raise the building 12 inches (30.5 cm) above the ground on stone foundations or piers.

Careful, annual inspections will also be required for termites in these sills. Continued contact with the soil provides the best possible conditions for their attack.

Willie Gibbons Farm

House. -- The drainage needs to be improved at the front of the house between the porch and the bank. Again, provide a gently sloping ditch at the front of the house to divert water away from the house. Run-off from rain and snow, and the presence of active springs, permit water to run under the porch (figure 16). Subsurface drains, such as perforated, plastic pipe, can be used to carry spring water along the bank and past the end of the house. The chimney of this structure needs to be flashed and capped. See figure 17. Some tar was apparently used to seal the joint on the east side at the juncture of the roof. It should be inspected annually, because these joints frequently leak. Snow infiltration of the attic can be reduced by closing holes

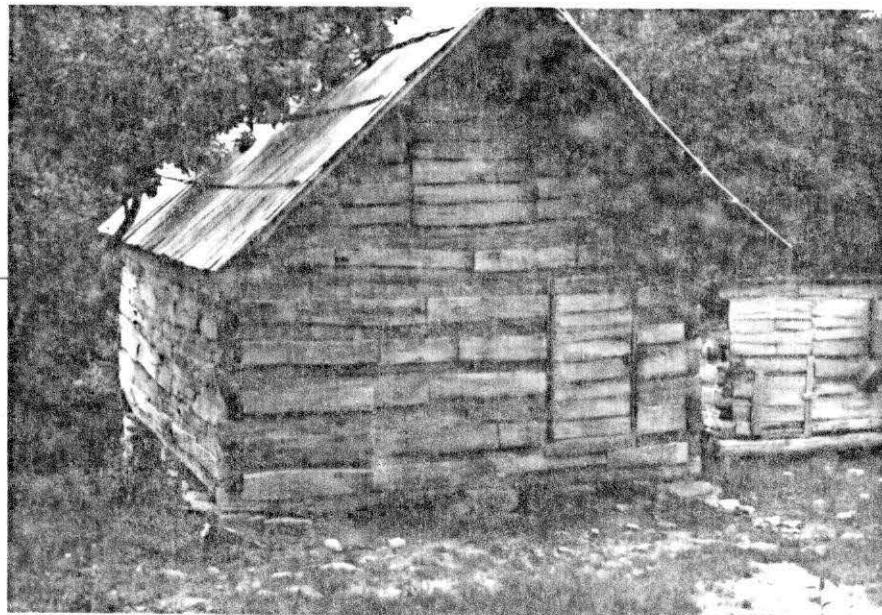


Figure 14.--The corn crib is too close to the ground.

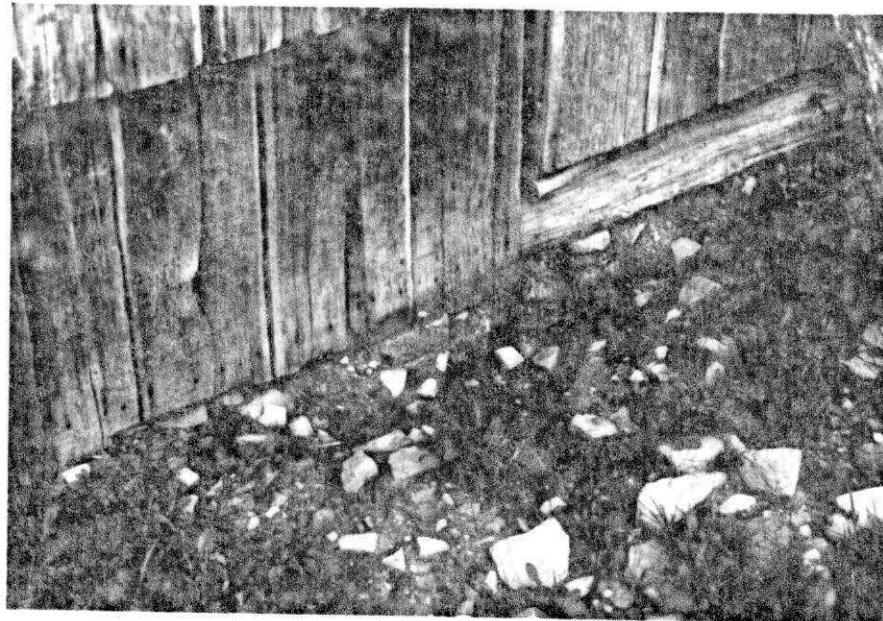


Figure 15.--The center sill of the barn is against the ground. It has begun to decay. Soil should be removed from around it and should be placed on stone pier.

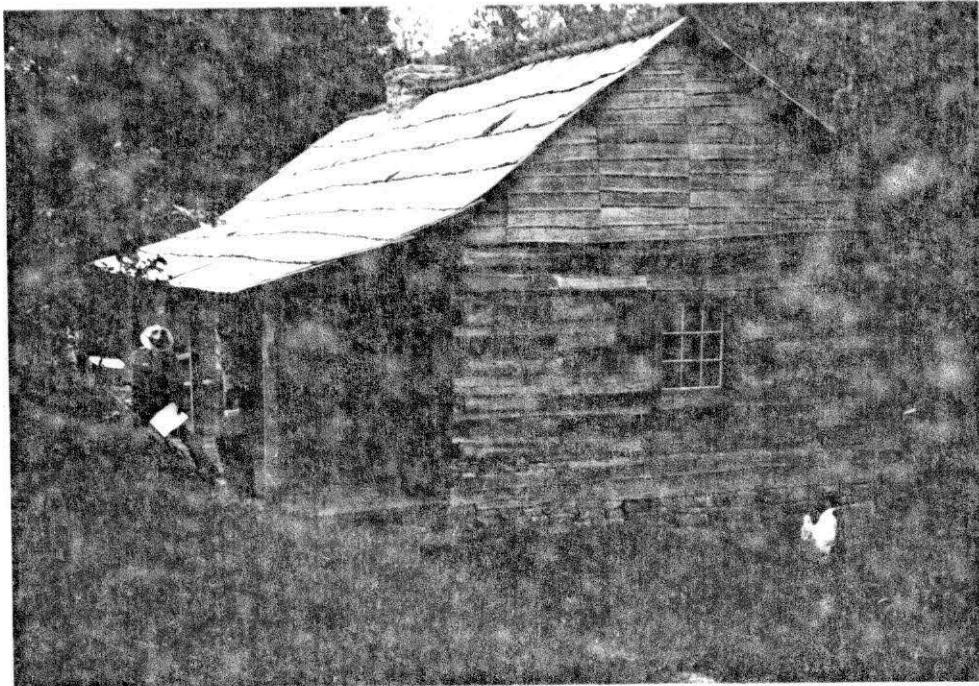


Figure 16.--Steep slope immediately in front of the porch. Drains should be provided to permit spring water and drainage to run past the end of the house.

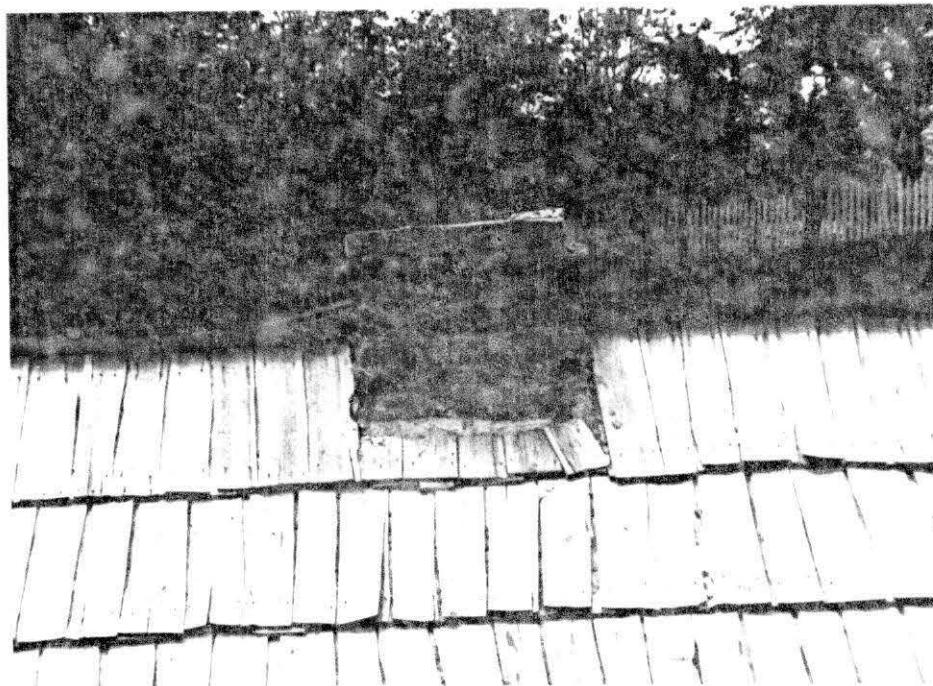


Figure 17.--Wide opening at the ridgeline. Shingles should have been laid tighter during reconstruction. Notice also the lack of flashing and the separation of the tar sealer around chimney.

and reducing drafts. Most cracks, especially in the shingles, probably cannot be sealed to wind-blown snow. Shingle roofs can leak snow but not leak rain water. If there are rain water leaks, they should be repaired. However, because of the design snow may still enter. The best solution is to winterize the structure as much as possible by closing the ridge crack (figure 17). Snow probably blows in along the ridge; block it off with a board during the winter. The ridge opening in this building seems to be wider than most. The shingles should have been laid tighter, at the time of reconstruction. If the ridge and gable cracks are closed permanently louvered vents must be installed for ventilation.

Blacksmith Shop. -- This structure has serious problems. The sill logs are on the ground (figure 18). The chimney is not flashed nor capped. The building lacks adequate ventilation. The roof leaks, and the drainage on the north side is poor (figure 19). The dirt floor of this structure is so wet that it has attracted crawfish. To correct these problems, the drainage, particularly along the road, should be improved, perhaps with a ditch between the road and the building. The roof leaks should be repaired; the chimney should be flashed and capped, and the shutters should be opened during the day to improve ventilation.

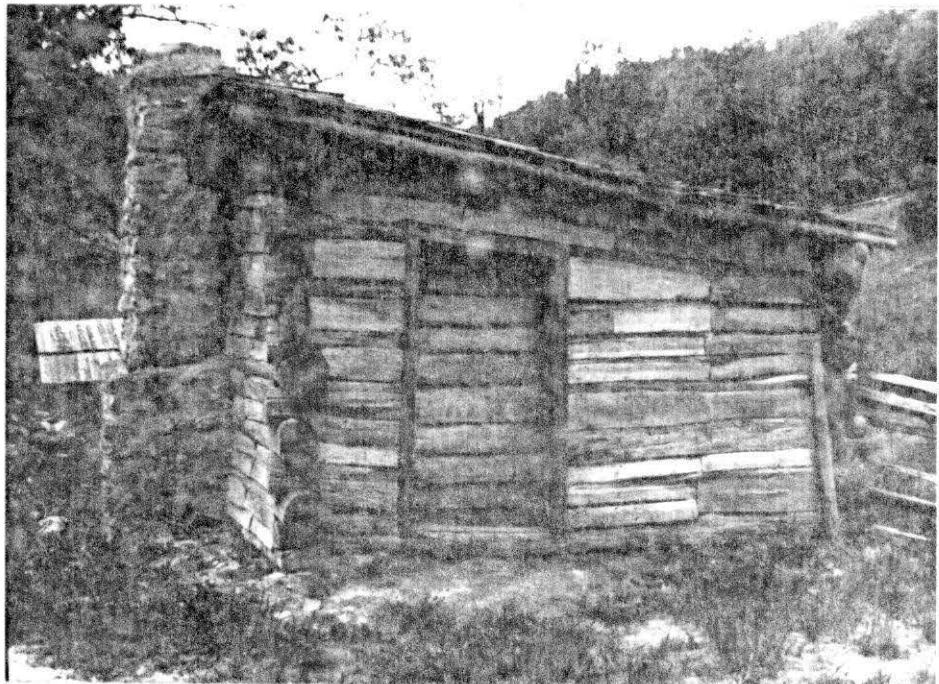


Figure 18.--Note sill logs are in contact with the soil. Raising this building would affect the chimney, so the most practical solution is to remove the soil from around the logs. Put them on stone piers.



Figure 19.--Poor drainage permits silt and water to flow against the sill of the blacksmith shop. A drain along the road should be provided to move water away from the building.

Sheep Barn. -- The sill logs rest on the ground and the drainage from the road flows through the barn (figure 20). The best methods for correcting these problems are: (1) raise the building on stone piers, (2) dig a ditch between the road and barn, and (3) improve drainage along and away from the north side of the barn. Once the building is raised, the opening can be closed with a stone wall capped with termite shields. Such a foundation was not present and may not be historically accurate. The sills will have to be replaced in a few years unless something is done to keep them dry.

Main Barn. -- Again, sill logs are too close to the ground (figure 21). The drainage also needs to be improved on the northeast side at the drip line. Water from the roof wets the soil along the foundation. One problem that probably can't be corrected now is the lean of the building. The northeast wall is not plumb. Thus, rainwater from the roof falls close to the sill at the base of the wall (figure 22). This is another reason to plumb walls during reconstruction.

Other Outbuildings. -- Most of the problems with the remaining structures on this farm concern wood in contact with or too close to the ground. For example, the east wall of the spring house, and the skirtboards of the hen house (figure 23) are subject to decay and insect attack. However, repair or

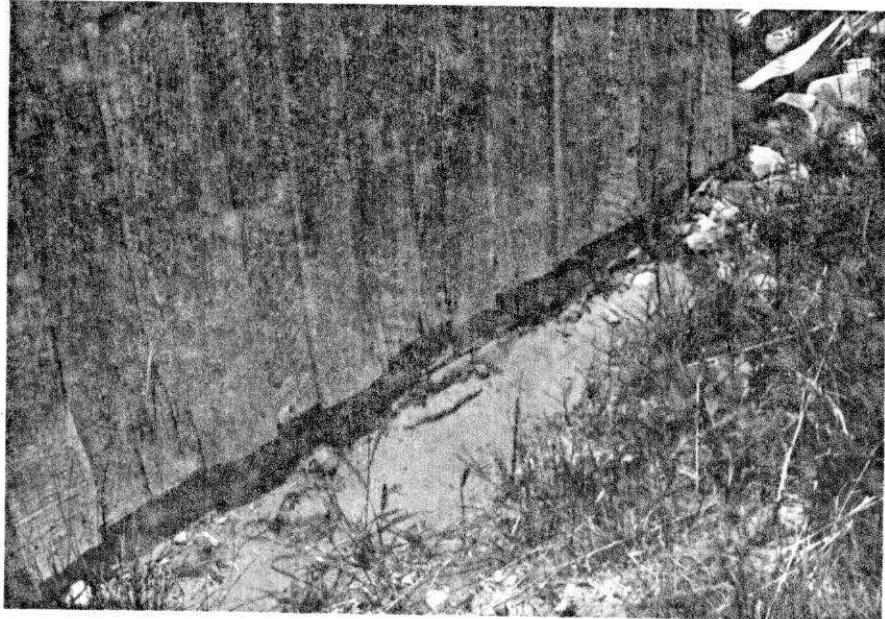


Figure 20.--Sill logs are in contact with the soil.
Notice the collection of fresh silt
against sill of the sheep barn.

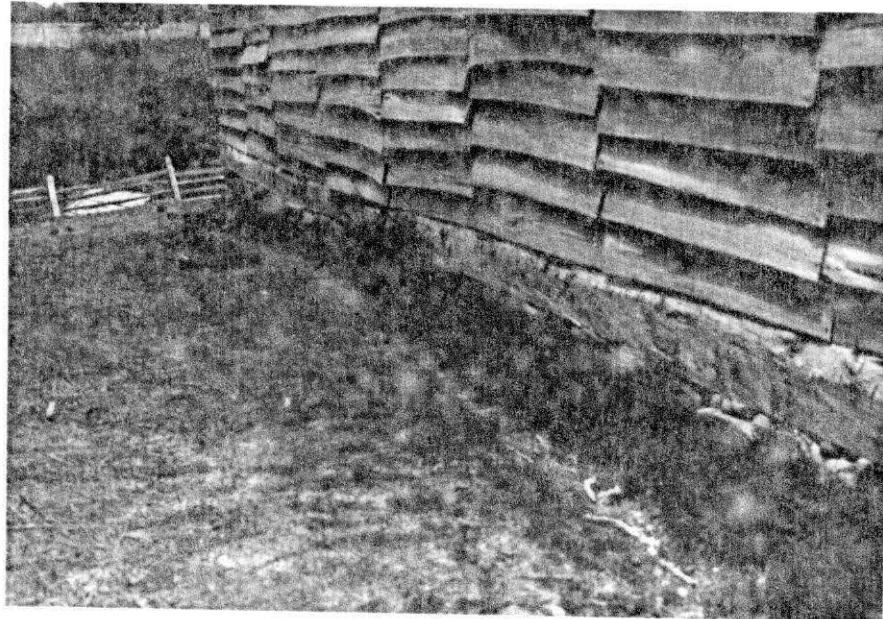


Figure 21.--Sill is too close to the ground and
subjected to splashing from roof run-off.

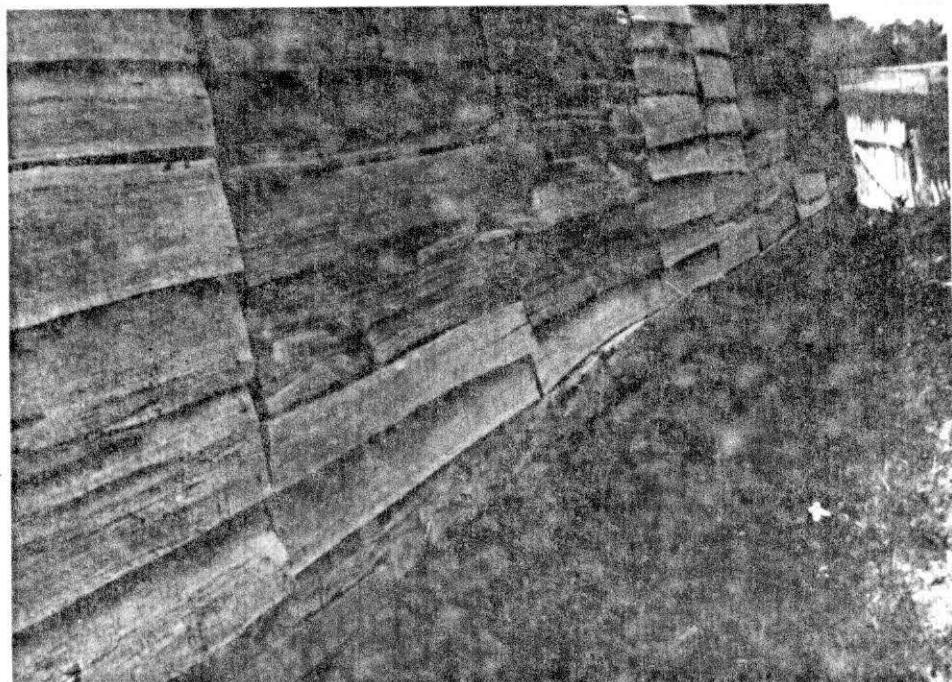


Figure 22.--Building is out of plumb, thus water falls close to the bottom of the wall. Building should have been plumb when reconstructed.



Figure 23.--Skirt-boards of the hen house. In this case, replacement upon decay may also be easier than changing the building.

replacement of affected logs or boards will not be too costly when that occurs. The woodshed should not suffer serious problems as long as the soil is kept away from its east wall (figure 24). The stone slab at the door of the smokehouse should be moved back from the log (figure 25). Water runs over the stone and against the log.

Wood Fences. -- Wood fences cannot be kept dry. Therefore, they should be made from the heartwood of naturally durable species, such as black locust, or from preservative treated wood. Both pressure treated posts and posts treated on site by the cold soaking process can be used. As sections of the present fence need replacing, this type of fencing material should be installed.

Wood Shingles

The roof shingles on all of the buildings at the Hensley Settlement appear to have been replaced at the time of reconstruction. Because the shingles are fairly new and because they were properly installed, they are presently in good condition. However, the species of wood used to make most of the shingles was red oak. Red oak is not a naturally durable species and early shingle failure can be expected. When the present shingles

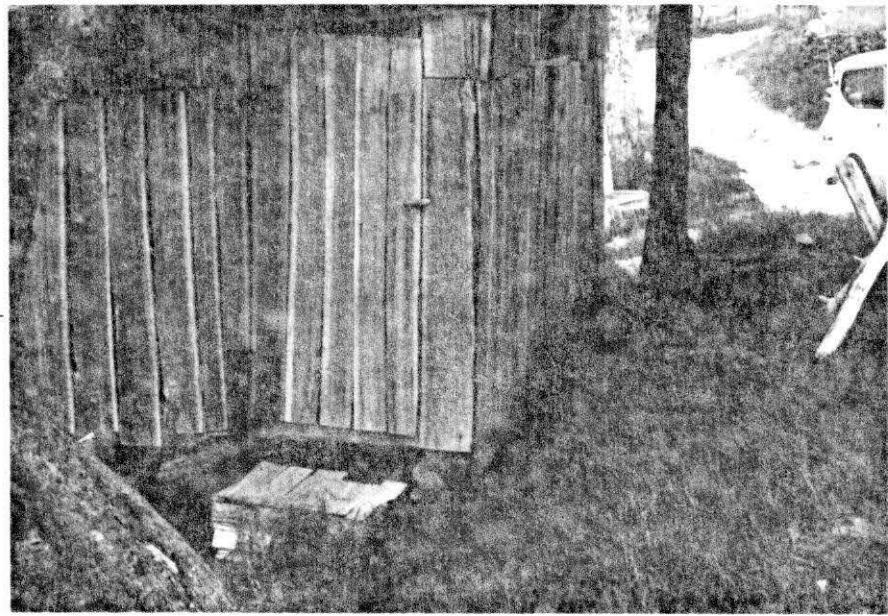


Figure 24.--Soil has been removed from in front of the woodshed to break contact with the soil. This opening must be kept free of soil, vegetation and debris.

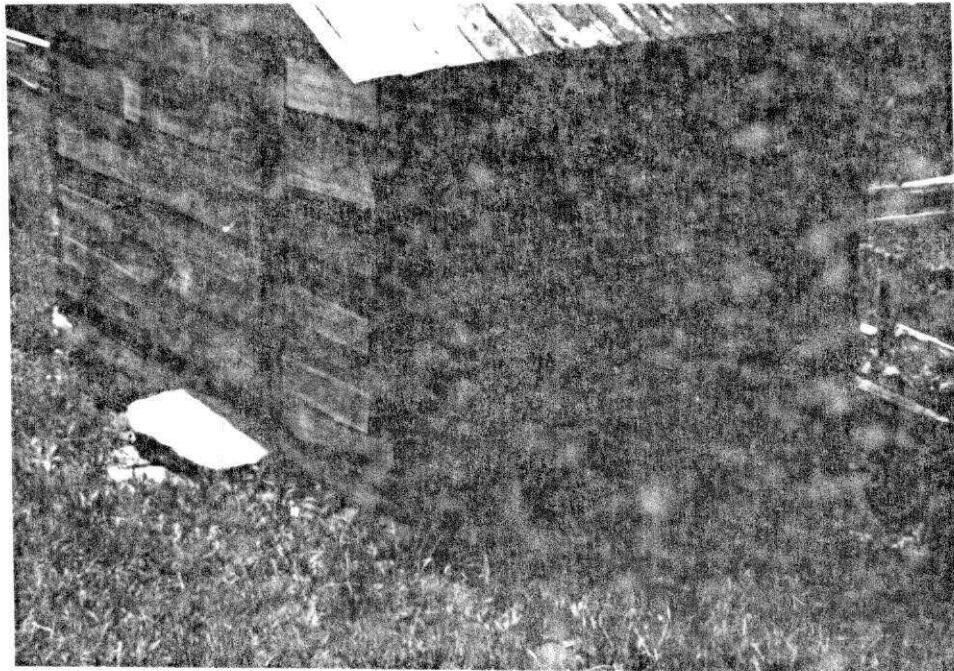


Figure 25.--Stepping stone permits surface run-off to flow against the sill. It should be moved back to provide a space between them.

RECOMMENDATIONS

Many of the problems at Hensley could have been avoided with a few simple procedures. Among them, the foundations should have been high enough to provide at least 12 inches between the soil and wood. Such changes may not conform strictly to the desire and need to retain the historical integrity of these and similar structures. However, higher foundations and chimney flashings may be necessary, even if new, to protect the historical fabric and prevent costly repairs in the future. One thing is certain: there is no simple solution that can substitute for a good knowledge of wood deterioration. Coupled with this, an annual inspection should be conducted to identify potential problems. When problems are found, they should be treated according to need. Blanket coverages with preservatives such as pentachlorophenol in mineral spirits is not the answer to preventive maintenance.

Remember, these buildings were not built to last forever. Efforts to restore them may thus defy the laws of natural biodegradation. To do so may require a departure from historical accuracy in some cases. Those buildings that were poorly built, i.e., sill logs in contact with the soil are no longer here to preserve. At Hensley, many of the sills were replaced at the time of reconstruction.

SUMMARY

1. Keep wood as dry as possible. If it gets wet, provide for rapid redrying.
2. When and where possible, raise buildings far enough to provide a minimum of 12 inches (30.5 cm) between the soil and wood.
3. In cases where buildings cannot be raised, trench away from both sides and beneath sill logs. As soil is removed, replace it with stone piers. Again, the soil should be a minimum of 12 inches (30.5 cm) from wood.
4. Where drainage is poor and water is being held close to sills and foundations, alter the grade to move water away from them.
5. Flash and cap chimneys.
6. Repair all roof leaks.
7. Ventilate attics, basements and shuttered buildings at the ratio of 1 square foot of vent to 150 square feet ($10\text{ cm}^2 : 15\text{ m}^2$) of floor area.
8. Reconsider, upon reconstruction, the omission of moisture retaining mortars in walls.
9. Remove wood debris from under buildings.
10. Inspect replacement materials, particularly from other old buildings, for evidence of decay or insect activity.
11. Inspect the structures annually to identify specific decay and insect problems before recommending treatments.

12. In crawl spaces where ventilation is poor, use soil covers to reduce the quantity of water evaporating into the air.
13. If a concrete floor is to be installed in a basement, first cover the gravel or soil with polyethylene to reduce moisture movement up through the slab and into the air above.
14. Install termite shields where possible.
15. During reconstruction, keep buildings plumb.
16. Use wood impregnated with wood preservatives (pressure treated) in high risk situations such as roof shingles.

PRECAUTIONARY PESTICIDE USE STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key -- out of the reach of children and animals -- away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is a danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

If your hands become contaminated with a pesticide, do not

eat or drink until you have washed. In case a pesticide is swallowed or gets in the eye, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land - fill dump, or crush and bury them in a level isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U. S. Department of Agriculture, consult your county agricultural agent or State Extension specialist to be sure the intended use is still registered.

SUGGESTED READING

Cox, W. E.

1978. Hensley settlement: a mountain community. Eastern National Park and Monument Association. 64 p.

DeGroot, R. C.

1976. Your wood can last for centuries. U. S. Dep. Agric.

For. Serv. South. For. Exp. Stn., Gulfport, Miss. 24p

Haverty, M. I.

You can protect your home from termites. U. S. Dept.

Agric. For. Serv. South. For. Exp. Stn., Gulfport, Miss. 12p

McIntyre, T.

1972. The old house borer. U. S. Dep. Agric. For. Serv

Northeast For. Exp. Stn., Broomall, Pa. 8p.

Rowell, R. M. et al;

1977. Protecting log cabins from decay. U. S. Dep. Agric.

For. Prod. Lab. Gen. Tech. Rep. FPL-11. 11p.

Scheffer, T. C. and A. F. Verrall.

1973. Principles for protecting wood buildings from decay.

U. S. Dep. Agric. For. Prod. Lab. Madison, Wis. Res. Pap.

FPL-190. 56p.

Sherwood, G. E.

1975. New life for old buildings appraisal and rehabilitation.

U. S. Dep. Agric. For. Serv. Agric. Handb. No. 481. 99p.

U. S. Dep. Agric.

1974. Wood handbook: wood as an engineering material. For.

Serv. Agric. Handb. No. 72

Williams, L. H.

1978. Homeowner's guide to wood-destroying insects. U. S.

Dep. Agric. For. Serv. and Coop. Ext. Serv. pamphlet.

Levi, M. P.

1977. Pressure-treated southern pine: some questions and answers
Wood Tips, North Carolina Agric. Extension Serv. AG 99

Gjovik, L. R. and R. H. Baechler.

1977. Selection, production, procurement and use of preservative
treated wood. U.S.D.A. For. Serv. For. Prod. Lab. Madison, Wis.
Gen. Tech. Rep. FPL-15.